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One other criticism of the unified course occurs to the writer at this time — the difficulty of a student referring to a text arranged for a unified course, when at some later time he wishes to use some formula or rule which he has forgotten. This difficulty, however, can easily be met by the compiling of a good index, and every student ought to learn the use of such an index, instead of shuffling the pages of his book till he finds what he wants. If the student of a unified course wishes to refer to some of the special texts of algebra, geometry, calculus, etc., it might be possible that he would not know what texts to consult — not know whether he ought to look in an analytic geometry or a calculus. But this difficulty seems so unlikely that it is hardly worth considering.

It is not to be assumed that all mathematics through the first course in calculus should be arranged in a single unified course. In fact, the break in going from the secondary school to the college seems to be an argument against such a large consolidation and to point to the desirability of at least two such unified courses.

Finally, such unified courses in the mathematics through the first course in Calculus are directly in line with what has long been done in the higher mathematics, as shown by the courses in analysis given by the French, and to some extent by the Germans, for advanced students. Surely a method which is so valuable there ought to be considered for other grades of work, unless the teaching of elementary mathematics is regarded as perfect at the present time; and the lively discussion of questions of teaching by the various associations of teachers makes one believe that the teachers are not so content with the present results.

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JORDANUS NEMORARIUS AND JOHN OF HALIFAX.

By L. C. KARPINSKI, Teachers College, Columbia University.

Cantor closes the first volume of his *Geschichte der Mathematik*[1] with the names of Leonard of Pisa and Jordanus Nemorarius, stating that these men mark a new period in the development of mathematical science. Cantor's discussion[2] of the part played by Jordanus in opening a new era rests largely on the Schonerus edition[3] of an anonymous mediaeval *Algorismus Demonstratus* which was long attributed to Regiomontanus, for no other reason apparently than that Regiomontanus made a copy of a Vienna manu-

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1). Vol. I, 3d edition, p. 911.

2). Vol. II, 2d edition.

3). D. E. Smith, *Rara Arithmetica*, pp. 178-179. Curtze (note, p. 20, Einige Materialen zur Geschichte der Mathematischen Facultaet der alten Universitaet Bologna, S. Gherardi, translation by Max. Curtze, Berlin, (1871), states that there is a XIV cent. Ms. in the library of Basle.

script of the same, which copy was used by Schoener for his edition[1]. The text is now attributed to an unknown Magister Gernardus[2]. Enestroem states[3] that the *Algorismus demonstratus* seems to have been unknown to the older writers on the history of mathematics. In a later article[4] he points out that the question as to which Algorismus Jordanus wrote seems to be very complicated, since there are several extant which are attributed to him[5].

In looking over the work of Wallis[6] on the early history of our numerals, chapter IV, *Quam antiquus sit harum in his regionibus Figurarum Numeralium usus,* I chanced upon a reference to an *Algorismus demonstratus* by Jordanus which is of sufficient importance to warrant giving the extract in full[7]. It should be noted that Wallis was a scholarly writer upon whose information we are able to rely. This reference antedates the work of Chasles,[8] mentioned by Enestroem as the first notice, by over one hundred and fifty years. The quotation is taken from the English edition of the Algebra which appeared in 1685.

"We have also, in Manuscript," says Wallis, "another treatise of *Algorism,* of *Jordanus,* (whom Vossius placeth about the year 1200 and contemporary with that *Campanus,* who wrote *De Computo Ecclesiastico* ;) entitled *Algorismus Jordani, tam in Integris quam in Fractionibus, demonstratus* ;[9] in which, the use of these Figures, and the way of numbering by them, is with great accuracy described and demonstrated. Which *Algorism* of his is very different from his *Arithmetica,* published and illustrated by *Faber Stapulensis* ; yet so, as it may very well be judged, by his manner of demonstration, to be a work of the same man. And the Manuscript itself, as appears by the hand and by the shape of the Figures, is very ancient. And in the same Manuscript book, wherein that of *Jordanus,* and some other small pieces are written, I found at the end of it two Celestial Schemes, relating to the year 1216 ; the one of them is called *Figura Anni,* representing the position of the Heavens on *March* 22, 1216 ; the other, *Figura Conjunctionis Saturni et Martis,* shewing the position of the Heavens at the time of that Conjunction which happened the same year, *October* 4, 1216. They are both of them described by these Numerical

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1). G. Enestroem, *Ist Jordanus Nemorarius Verfasser der Schrift "Algorithmus Demonstratus?"* Bibl. Math. 5_3, pp. 9-14.

2). P. Duhem, Sur l'Algorithmus Demonstratus, Bibl. Math. 6_3, p. 13.

3). L. c., note p. 9.

4). *Uber die "Demonstratio Jordani de Algorismo."* Bibl. Math. 7_3, pp. 24-30.

5). See also G. Enestroem, *Uber zwei angebliche mathematische Schulen im christlichen Mittel alter,* Bibl. Math. 7, pp. 252-262, and *Uber eine dem Jordanus Nemorarius zugeschrievene kurze Algorismusschrift,* Bibl. Math. 8_3, pp. 135-153. P. Treutlein, Abhandlungen zur Geschichte d. Math. Vol. II.

6). Johannis Wallis, Opera Mathem., Vol. II, Oxford, 1693.

7). In a personal letter from Mr. Enestroem to the author he states that this book is still in existence, Codex Savil. 21, Oxford, and that it was examined by Professor Bjornbo in 1906. It contains the text of the *Demonstratio Jordani de Algorismo.*

8). Apercu historique etc., Brussels, 1837.

9). The Latin version, Opera Omnia, vol. II, p. 13, is *Algorismus Jordani, tam in integris quam in fractis, demonstratus.* It adds also *Codex Saviliensis.*

Figures; and, in likelihood, were calculated about that time, in order to some Astrological Predictions to be made thereupon. And it so happens, that this last page of that Piece, proves to be the latter leaf of that same piece of Parchment, which begins that Book of *Algorismus Demonstratus* and therefore later written than it."

This statement by Wallis further complicates the matter under discussion,[1] as in the other works ascribed to Jordanus there is no special mention in the title of fractions, and in the treatment of fractions the name is given either as minutiæ philosophicæ or phisicæ (Sexagesimal fractions) and minutiæ vulgares (common fractions).

At the same time it would seem to show that some Jordanus did write an Algorismus about the beginning of the thirteenth century. Of men by the name of Jordanus several of about this time are well known in Church History[2] and, doubtless, there were others outside of the church. Jordanus Nemorarius is identified by Cantor with Jordanus de Saxonia (c. 1190-1237) of the order of Dominicans, based partly upon some early chronicles and partly upon the fact that this work often appears in the same volume with other works which are quite certainly the works of the Dominican. The name Nemorarius nowhere appears in the letters or writings of Jordanus of Saxonia, and the derivation of the appellation Nemorarius from his birthplace[3] rests upon an error in assuming the same to be Borrenstrick.

If the Saxon Jordanus did write any of these algorisms it is highly probable that this work had considerable influence in spreading the knowledge of our numerals throughout Europe, for as head of the order of Dominicans this man made many journeys over all of Europe; indeed he perished in a shipwreck in February, 1237, on the return voyage from a trip to the Holy Lands.[4] He had a reputation as a brilliant orator and is said to have made a thousand converts to his order. It would indeed be rather surprising if, in his wanderings, he had not somewhere learned and discussed the new symbols which were then coming into use.

Concerning the influence and even the identity of Jordanus we are much in doubt. In regard to the influence of John of Halifax there is no doubt. Maximilian Curtze,[5] who made a special trip through European libraries in search of Mathematical MSS., found that there are forty-five copies of the Algorismum of Sacrobosco in the three libraries of Munich, Vienna, and Erfurt (Amploniana). The Coxe catalog of an Oxford library gives ten further and there are doubtless numerous others extant in Europe. Of those mentioned at least seven are of the thirteenth century and the

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1). See, however, note 7 above.

2). Potthast, *Bibliotheca Historica Mediaevi*, mentions four who lived between 1175-1300.

3). By Cantor, vol. II, J. J. Bertheir, *B. Jordanis de Saxonia, Opera, Friburg*, 1891, states that J. was born in Westphalia, not Borrenstrick. L'abbe E. Bernard, *Les Dominicains dans l'Universite de Paris*, Paris, 1883, largely on Jordanus.

4). Acta Santorum, Feb. 2, vol. II, pp. 720 ff.

5). *Petri Philomeni de Dacia in Algorismum vulgaren Johannis de Sacrobasco Commentarius*, Copenhagen, 1897, Max. Curtze.

others of later date up to the sixteenth century. In America there are two copies, one in the Plimpton Collection[1] and the other in the Columbia University Library. Both of these copies are the work of the fifteenth century.

In addition to the Algorismus of John of Halifax there are numerous commentaries on this work extant of which some also go back to the thirteenth century. Of these the one which seems to have been most widely used was that made by Petrus de Dacia in 1291. Of this commentary[2] five copies are mentioned by Enestroem[3] and five further by Curtze in the work cited. One Petrus de Dacia is given[4] as Rector of the University of Paris in 1326 and he may very well have been the author of this work. Petrus de Dacia wrote further a multiplication table from 1x1 up to 49x49,[5] a *Tabula de Loco Lunae,*[6] a Calendar and also a work "de calculo seu computo" which was probably on the computation of Easter.[7]

John of Halifax (Holywood, Holywod or Holiwod, Halifax, Holifax, Holybush, Holywolde Sacro-Busto or -Bosco, Sacrobosco, Sacrobuschus or Sacrobusto[8]) was born at Halifax, Yorkshire, studied at Oxford and later wandered to Paris where he lectured on mathenatics and astronomy. His most famous work was probably the *Sphaera mundi,* also known as *Libellus de Sphaera,* a treatise on astronomy which was used as a text-book in the Universities of the Middle Ages for several centuries.[9] He wrote further a *Computus Ecclesiasticus* and this *Algorismus,* which appears now to have been quite as popular from 1250-1550 as was the work on astronomy. The Algorismus was first published in Strassburg in 1488[10] and numerous editions followed. The text has been published also under the title *Tractatus de Arto Numerandi*[11] and *Oposculum de praxi numerorum quod Algorismum vocant.*[12] Copies of this work have been frequently attributed to other writers. The Plimpton Library MS. was ascribed to Mugling until Professor Smith made an examination of the text, while more recently an *Algorismus Doctrinalis* in the Hunterian Museum at Glasgow[13] is attributed to Michæl, Monk of Dover. As the opening and closing lines which are given are identical with lines in Sacrobosco's *Algorismus* it is seen to be the work of the same man, and this text is probably a student's copy made by this Michæl.

Nor is it to be suspected at all, that any attempt was made by the

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1). D. E. Smith, *Rara Arithmetica.*

2). Text by Max Curtze, l. c.

3). In publications of the Royal Danish Academy.

4). Potthast, Bibl. Historica Mediiaevi, who also mentions a Petrus de Dacia, Monachus Vistyensis, lector Skeningae, a. 1271-1275.

5). Enestrom, Bibl. Math., 1890, p. 32.

6). *A Catalog of the Manuscripts in the Library of the Hunterian Museum* in the University of Glasgow, begun by John Young and completed by P. H. Aitken, Glasgow, 1908. Other copies are in the British Museum, additional MSS., No. 35, 317, f. 1, in Oxford Univ. Lib. (Catalog of MSS., Ashmole, 1845), and in Paris.

7). Vossius, De Universae Mathesios Natura et Constitutione, Amstel., 1650.

8). Vossius, l. c., Smith, *Rara Arithmetica.*

9). Aschbach, J., *Gesch. d. Wiener Universitaet im erster Jahrhunderte ihres Bestehens,* Wien, 1865, p. 93.

10). Smith, l. c., pp. 31-33.

11). Halliwell, *Rara Mathematica.*

12). Paris, 1510, Clichtoveus edition.

13). Young and Aitken, l. c., pp. 388-389.

copyists of this work to take the credit for its composition. Many of the copies found are, doubtless, simply students' lecture notes which were, of necessity, as the use of this work was largely before the invention of printing, written out. Even a slight examination of the Columbia MS. and the Plimpton MS. shows such marked divergence in phraseology from the text published by Curtze (and from each other) that we are led to conclude that these were lecture notes largely for the personal use of the writer. The shorthand character of the writing, making their reading practically impossible in many places, further confirms this view.

This *Algorism* of Sacrobosco is of interest for the reason, also, that it is probably due to the extended use of this work that the appellation Arabic numerals became common. In two places there is mention of the inventors of this system. In the introduction it is stated that this science of reckoning was given out by a philosopher named Algus whence the name *Algorismus.* Petrus de Dacia recognizes the Arabic origin of the word Algos,[1] stating that this is the name of some Arabic philosopher. The Columbia manuscript gives also the derivation of *Algorismus* from *ars+rismos* which word means number. In the section on numeration reference is made to the Arabs as the inventors of this science.[2] While some of the commentators knew of the Hindu origin, e. g., Petrus de Dacia,[3] most of them undoubtedly took the text as it stood and so the Arabs were credited with the invention of the system.

In conclusion it may be well to state that this and the *Algorismus* of John of Lima are the two of the oldest works known which bear the name of al-Khowarazmi, for the work of Frater Sigsboto which was published by Curtze under the title *Ueber eine Algorismus-schrift des XII Jahrhunderts*[4] nowhere uses the term *Algorismus.* There is also the Saliminian Codex[5] of the end of the twelfth century (textual evidence of date, as it bears no date nor name of author), and the *Carmen de Algorismo*[6] of Alexander de Villadei of which some lines are quoted by Sacrobosco.

John Bale, who made an examination of English Libraries before 1548,[7] gives Marianus Scotus (1208-c. 1382) as the author of an Algorism. In the absence of any further knowledge of the MS. lost since, at least, 1748,[8] we cannot place much emphasis upon this statement. At the same time it is well to note that another *algorismus* of about this same time is credited to Guido Arezzo by Wailly[1] on the authority of the Benedictines, and also in the Nouveau traitê Diplomatique, in which the work is given as a computation on the sand table. This is the more likely inasmuch as several Arabic works written before 980[2] refer to calculation on a table, and to calculation without erasure. There is also a Computus of the XI century by Marianus in the Trinity College Library, bound with some arithmetic of the XII century.[3]

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[1]. "Quidam philosophus editit nomine Algus, unde et *Algorismus* nuncupatur," Curtze edition, l. c. p. 1. "Algorismus ab algos," Columbia MS. "Edidit Algus," also "Explicit Algorismus" at end, Plimpton MS.

[2]. "Sinistrorsum autem scribimus in hac arte more arabico sive indaico, huius scientiae inventorum," Curtze edition, p. 3. The Plimpton MS. omits the words "sive indaico."

[3]. "Non enim omnis numerus per quas cum que figuras in dorum repraesentatur," Curtze edition, p. 25.

[4]. *Abhandlungen zur Geschichte der Mathematik,* vol. VIII.

[5]. Index Britanniae Scryptorum, Joannes Balens, edited by R. L. Poole, Oxford, 1902, p. 287, "Ee collegio Martonensi, Oxon.

[6]. Halliwell l. c. This Carmen was widely used as shown by the large number of manuscript copies found in European libraries.

[7]. Index Brit., Script., 1548.

[8]. Tanner, Bibl. Britanno Hibernica, London, 1748,

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REVIEW OF A SIGNIFICANT TEXT IN CALCULUS.*

By N. J. LENNES, Massachusetts Institute of Technology.

This little book, entitled Elements of Differential and Integral Calculus, deserves more than a passing notice, especially because it is intended for a class of students differing considerably from those who now study elementary calculus in our colleges and universities. As stated in the preface, it is the result of a series of lectures delivered during the last six years to classes consisting chiefly of students of engineering and chemistry. In working over the lectures "it soon appeared," continues the preface, "that the mathematical knowledge which needs to be possesseed by a student before attempting the calculus is very much less than has been supposed. For example, the binomial theorem of algebra and the addition theorem of trigonometry are quite unnecessary. This book is written with the view of making the subject more easily and generally accessible than it has been hitherto. The principles of the differential and integral calculus ought to be counted as a part of the intellectual heritage of any educated man or woman in the twentieth century no less than the Copernican system or the Darwinian theory. In order to make a beginning no previous knowledge of mathematics is needed beyond the most elementary notions of geometry, a little algebra, including the law of indices and the definitions of the trigonometric functions."

The general mode of presentation bears striking evidence of the influence of recent discussions of mathematical pedagogy. The consideration of each new process is preceded by concrete and simple problems in the solution of which the process is required. The simplicity of the problems themselves leaves the mind free to concentrate upon the one new thing offered for consideration, namely, the process of solution.

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1). Elements de Paleographie, Paris, 1838, vol. I, pp. 711-716.

2). *M. Suter, Abhandlungen zur Geschichte der Mathematik, Fihrist*, pp. 37, 40, 41.

3). *Trinity College Library, Catalog of Manuscripts.*

*Elements of the Differential and Integral Calculus by A. E. H. Love. Cambridge University Press, pages 204+XIII.